INVASION AND STABILIZATION OF RECENT BEACHES BY SALT GRASS (*DISTICHILIS SPICATA*) AT MONO LAKE, MONO COUNTY, CALIFORNIA

Jack D. Brotherson[1] and Samuel R. Rushforth[1]

ABSTRACT.— Invasion of plant species onto recently exposed beaches of Mono Lake, California, was documented. Three vegetation zones were evident on these beaches. The first was formed entirely of annual species. The second was composed of annuals mixed with salt grass, and the third was formed entirely of salt grass. Stabilization of these beaches was accomplished by the aggressive growth of salt grass rhizomes.

Present-day Mono Lake is a saline remnant of Pleistocene Lake Russell. Mono Lake lies in Mono Basin with no outlet drainage (Fig. 1). The lake is fed by five major tributary streams flowing off the east slope of the Sierra Nevada. Until recently, this flow had been sufficient to maintain the lake at or near pre-settlement elevation and salinity. However, in recent years the demand for water created by population growth in southern California has led to the construction of the Los Angeles Aqueduct and Tunnel System. This water capture system has tapped four of the five tributary streams of Mono Lake and has led to significant dewatering. This has resulted in increased salinity and a corresponding 13.5-m (44-foot) drop in water level since 1941 (Young 1981). This drawdown has left large areas of former lake bottom to become exposed beaches. One such new beach on the northwest part of the lake between Black Point and Niget Island is composed of black lava sands originating from volcanic explosions during the quite recent past.

Since the drawdown of Mono Lake during the last 40 years, a significant invasion of these new beaches by vascular plant species has occurred. The objectives of the present study were twofold. First, we wanted to determine what species were important in invasion, and, second, we wanted to document the invasion process and resultant stabilization of the beaches.

METHODS

Twenty 0.25-m quadrats were randomly located in each vegetation zone 27 August 1981. Cover for all plant species encountered as well as for litter and bare ground was estimated following the cover class category method suggested by Daubenmire (1959). Three soil samples were taken from the root zone (top 20 cm of soil) in each vegetational type and later pooled for laboratory analyses of abiotic soil factors.

Soil analyses were performed by the Soil Analysis Laboratory, Department of Agronomy, Brigham Young University, following standard methods. Plant nomenclature is after Munz (1959).

RESULTS AND DISCUSSION

The beach between Black Point and Niget Island exhibited three prominent vegetation zones that seemed to mirror three stages in the beach invasion process. The three zones included one dominated by annual species (Figs. 1, 2), a second dominated by the perennial *Distichilis spicata* (salt grass) (Figs. 5, 6), and a transition zone under invasion by *Distichilis* (Figs. 3, 4). A total of six vascular plant species was encountered in the three vegetation zones (Table 1). These species included only a single perennial and five annuals.

The general pattern of invasion of the new beach appeared to be first by the annuals and later by *Distichilis*. Establishment of saltgrass is not uniform but appears at random points across the beach. Once the saltgrass becomes established, it spreads dramatically by rhizomes (Figs. 3, 4) until it completely dominates the vegetation (Figs. 5, 6) and crowds out the annuals (Table 1). We measured some

[1]Department of Botany and Range Science, Brigham Young University, Provo, Utah 84602.

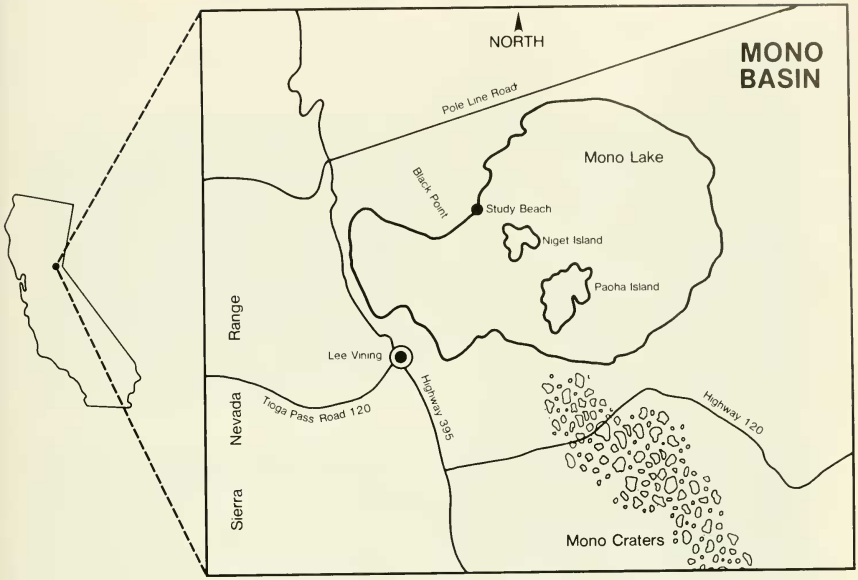


Fig. 1. Reference map showing study area at the edge of Mono Lake in Mono Basin, California.

TABLE 1. Percent cover of vascular plant species, bare ground, and litter in three zones on the beach between Black Point and Niget Island at the edge of Mono Lake, Mono County, California.

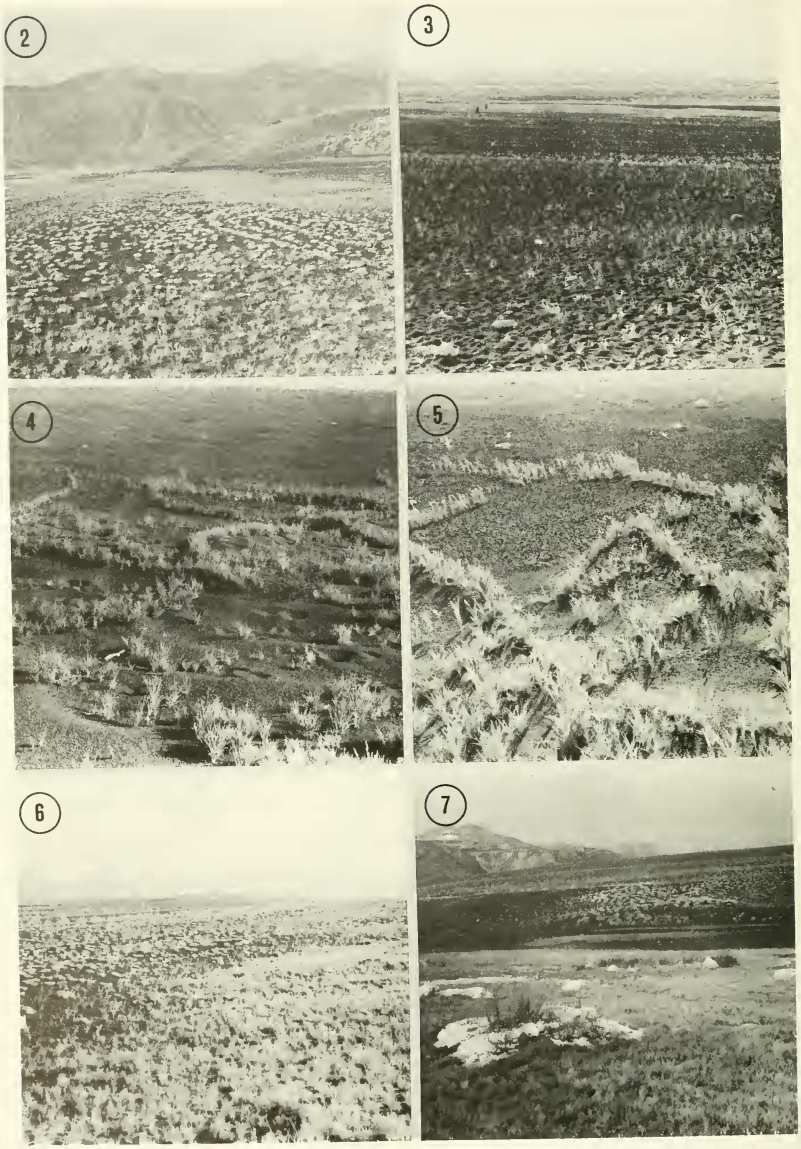
Species	Zones		
	Established *Distichilis*	Invasion zone	Annual zone
Bare ground	52.8	81.8	86.8
Litter	2.5	0.0	0.0
Psathyrotes annua	0.5	3.8	7.8
Distichilis spicata	47.3	11.3	0.0
Kochia scoparia	0.8	0.0	0.3
Mentzelia torreyi	0.0	0.5	4.3
Oenothera boothii	0.3	5.0	6.8
Salsola iberica	0.3	0.5	0.0

TABLE 2. Important physical and chemical factors in three zones of beach soils between Black Point and Niget Island at the edge of Mono Lake, Mono County, California.

Soil Factor	Zones		
	Established *Distichilis*	Invasion zone	Annual zone
Sand (%)	96.0	91.0	93.0
Silt (%)	3.0	4.0	3.0
Clay (%)	1.0	4.0	4.0
Conductance (μmhos)	760	400	420
Soluble salts	38000	20138	20138
pH	7.0	7.3	7.0
Nitrogen (%)	0.005	0.006	0.005
Phosphorus (ppm)	2.27	2.76	2.27
Calcium (ppm)	78.0	68.5	85.0
Magnesium (ppm)	3.0	2.5	4.5
Potassium (ppm)	312.5	295.0	421.0
Sodium (ppm)	112.0	208.0	624.0
Zinc (ppm)	0.58	0.54	0.56
Copper (ppm)	0.09	0.08	0.06
Manganese (ppm)	0.80	0.92	1.00
Iron (ppm)	4.10	5.32	3.68

of these rhizomes at more than 20 m long. In late stages in the invasion process, rhizomes proliferate and entangle until saltgrass cover reaches as high as 87%.

To assess whether vegetational zones may be delineated by edaphic factors, several important soil parameters were measured (Table 2). Noteworthy differences in parameters occurred only in soluble salts, conductance, and sodium. We believe these differences to be related to the fact that *Distichilis* has glands that secrete salts (Hansen et al. 1975) that would likely contribute salts to the soils where it grows. No major differences in other soil factors were evident between the three zones,



Figs. 2–7. Views of the beach between Niget Island and Black Point, Mono Lake, California: 2–3, Annual zone; 4–5, Transition zone showing long rhizomes of salt grass; 6–7, Salt grass zone.

suggesting that vegetation differences are due to invasional phenomena rather than soil factors.

LITERATURE CITED

DAUBENMIRE, R. 1959. A canopy coverage method of vegetational analysis. Northwest Sci. 33:43–66.

HANSEN, D. S. P. DAYANANDAN, P. B. KAUFMAN, AND J. D BROTHERSON 1976. Ecological adaptations of salt marsh grass. *Distichilis spicata* (Gramineae), and environmental factors affecting its growth and distribution. Amer. Jour. Bot. 63(5):635–650.

MUNZ, P. A. 1959. A California flora. University of California Press, Berkeley. 1681 pp.

YOUNG, G. 1981. The troubled waters of Mono Lake. Nat. Geog. 160(4):504–519.